Income Inequality as a Determinant of Economic Growth: A Cross-Country Analysis

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Abstract

In this study, we seek to find a relationship between income inequality and economic growth. Despite years of extensive research dedicated to finding a relationship between the two, past studies and existing literature still remain divided on the subject, with some finding a positive relationship and others declaring a negative relationship. This paper examines the effects of inequality on GDP by using data of 225 countries from 2011. Using this data, simple and multiple linear regression models were formed to determine the relationship between the two variables. Through empirical analysis, we found that statistical inference tests supported all variables. This study found a positive relationship between income inequality and economic growth. If further study is pursued, it should consider evaluating countries separately based on whether they are developed or developing, and testing different explanatory variables.

1. Introduction

The International Monetary Fund's January 2016 World Economic Outlook (WEO) Update reads that global economic growth is projected to grow 3.4 percent in 2016 and again in 2017 (IMF, 2016). In both advanced and developing economies, gradual growth is predicted initially but is expected to pick up in the next two years. However, there are factors that play into this goal that, if not successfully addressed, could derail economic growth (IMF, 2016). One of these key elements is wealth inequality, and as global economic interdependence and interconnectedness continues to increase, it becomes vital to analyze the relation between economic growth and inequality.

At this point in time, income inequality is a topic that is very prominent, especially with the 2016 presidential campaign currently going full force. Each candidate has their own notions and proposals for how to tackle the disparity in income. Income inequality impacts the poor and underprivileged the most, because the cost of living and the quality of life people live depends largely on their level of income. Since income level and quality of life are so interrelated, income inequality impacts the poor in several negative ways. The primary effect of income inequality is that it prevents capital accumulation (both human and physical) (Mo, 2000; Kaldor, 1956; Aghion, Caroli and Garcia-Penelosa, 1999). Secondly, inequality can generate socio-political instability that undermines incentives to save and invest, and would generate pressure on government (Mo, 2000). Finally, inequality has a detrimental effect on social mobility: countries with higher levels of inequality show a dependence of child's future earning capacity on the current earning capacity of their parents (Corak, 2013). Inequality, which currently shows no signs of undergoing income redistribution, is indisputably a problem that disrupts the balance within a society.

Economic growth has been a popular topic since the financial crisis of 2008. In fact, since the Great Recession, economic growth has been regarded as a sign of advancement, development, and recovery. During a period of economic growth, poverty and unemployment is reduced, the standard of living of the population rises, it incentivizes the young, and the country's currency appreciates against that of other countries', giving it more international trade power. Ultimately, all countries desire to experience economic growth in order to progress. According to a German proverb on the subject of growth, "Stagnant water starts to stink at some point" (New York Department of Health, 1909). Economies cannot stand still; either they can go up for they go down--and everyone wants to go up.

Without a doubt, economic growth is instrumental in poverty reduction in a country, but is economic growth related positively or negatively in regards to income inequality?

This paper declares a positive relationship between income inequality and economic growth, and we shall test this prediction empirically with regression analysis. Using cross-country data obtained from World Bank for the year 2011, we conducted regression analysis of economic growth on income inequality. Existing studies determined there to be a positive relation between income inequality and economic growth. This research contributes to the statement and proposes that with higher inequality, economic growth will continue to accelerate.

This paper is organized as follows. Section II draws literary support and analyzes existing sources to reinforce and elaborate on the research and hypothesis tests we conducted. Section III introduces the data and explains the techniques used to conduct our study. Section IV interprets the results from the data and analysis methods employed, and Section V concludes the findings of this research.

2. Literature Review

Despite there being a magnitude of literature on the link between income inequality and economic growth, there is a stark divide in findings as to whether there is a positive or a negative relationship. Numerous differing theories about whether these two variables are related positively or negatively originate largely from differing explanatory variables, differing years examined (leading to differing datasets), and differing empirical approaches since the 1950s.

2.1 Inequality and Economic Growth: The Perspective of the New Growth Theories

There is a consensus among many authors of literature that there is a negative relationship between the average rate of economic growth and the measure of inequality. (Aghion, Caroli, Garcia-Penalosa, 1999). Aghion, Caroli, and Garcia-Penalosa (1999) examined case studies of South Korea and the Philippines. According to their research, the ratio of the income share of the top 20% of the bottom 40% of the population in Philippines was almost twice as large as in South Korea. Despite their differences in degree of income inequality. these two countries demonstrated similar levels of macroeconomic health (through GDP per capita, investment per capita, average saving rates, etc) at the beginning of the study. Over the course of 30 years, however, Aghion, Caroli, and Garcia-Penalosa (1999) found a marked difference in the rate of growth between the two countries (Aghion, Caroli, Garcia-Penalosa 1999). They ascertained that South Korea's output level underwent a five-fold increase, while that of the Philippines barely doubled, demonstrating that the country with a higher level of income inequality grew at a slower rate. After they determined these results in a case study, they conducted research on redistribution to find whether redistribution fosters or hinders growth. Aghion, Caroli, and Garcia-Penalosa (1999) found that income inequality was found to be positively correlated with volatility, and through a series of cross-country regressions found that greater volatility reduces the average rate of growth during a set period. Their findings were bolstered with results declaring that redistribution has stimulating effect on economic growth, therefore determining that inequality has a negative impact on economic growth. These results coincide with other literature declaring a negative relationship between income inequality and economic growth.

2.2 A Non-Parametric Measure of Poverty Elasticity

In a study that yielded similar results, Chambers and Dhongde (2011) pursued a non-parametric approach to examine an extensive and up-to-date dataset from the World Bank, inclusive of 1977 through 2007, representing more than 96% of the population of the developing world. Rather than GDP, Chambers and Dhongde(2011) measured the growth elasticity of poverty (GEP) and found that countries with higher levels of inequality had lower GEP, and countries with lower inequality had higher GEP. Through more extensive research (and their non-parametric approach), they studied the typical linear model to measure the relationship between poverty, mean income, and the Gini index and found evidence that the relationship between income inequality and growth is best described as non-linear. Chambers and Dhongde (2011), by analyzing a model which considers the nonlinearity of the growth-poverty-inequality neux, found that poverty declines rapidly with higher mean income, but slowly with lower values of the Gini index. In short, their results were obtained using data that was much more comprehensive and methods that were more robust than those of most studies. Their findings reflect those of Aghion, Caroli, and Garcia-Penalosa (1999) as well as many others that have also found a negative relationship between economic growth and income inequality.

2.3 Income Inequality is Not Harmful for Growth: Theory and Evidence

While there seems to be insurmountable evidence in favor of a negative relationship between income inequality and economic growth, there are numerous studies that yielded a positive connection between the two variables. In an analysis conducted by Li and Zou (1998), the results stated that empirical evidence revealed through a regression of GDP growth rate on the Gini coefficient that income inequality is positively associated with economic growth. Following in previous literature's footsteps, Li and Zou (1998) followed Alesnia and Rodrik (1994) and Barro (1990) to find income inequality's relationship with economic growth by dividing government spending into production services and consumption services. However, in contrast with Alesnia and Rodrik (1994) and Barro (1990) according to their results, income inequality can lead to fast economic growth when government spending is wholly driven by public consumption. In fact, by using this extension of government spending, Li and Zou (1998) found that since government spending is all for consumption, individuals will try to allocate resources between public and private consumption. Therefore Li and Zou (1998) state that income inequality can generate high savings rates and growth rates if the rich have a larger share of income, or if income is more unequally distributed in the economy.

2.4 Income inequality and Economic Growth (Shin)

While some literature declare a positive relationship and others support a negative one, there are some studies in which no position is taken and both sides of the debate are examined and analyzed (Shin, 2012). Shin (2012) chose not to pursue a particular stance on the topic but rather chose to examine reasons why this disparity exists. According to Shin (2012), there is a correlation between the positive/negative relationship between inequality and economic growth and whether or not the country is developed or not. Shin (2012) performed a case study of East Asian and South American countries, which are developing countries. The findings revealed a negative relationship between income inequality and economic growth in those countries. Conversely, in a case study of the United States and France, which are developed countries, a positive relationship between income inequality and econ growth was found. In an agreement with Barro (2000), Shin (2012) declared that the effect of income inequality on economic growth was contingent on the state of economic development. Specifically, Shin (2012) found that income inequality in poor countries retards economic growth; that is, in countries with GDP per capita below 2070, the effect of income inequality is negative. According to Shin (2012), this is caused by a lack of opportunity to invest by the population of a developed country. This in turn would lead to political and social instability, which contributes towards economic growth decline. Therefore income inequality reduces economic growth. In contrast, income inequality in rich countries encourages growth; that is, in countries with GDP per capita over 2070, the effect is positive. Income redistribution from the rich to the poor reduces the saving rate of the economy which would lower the incentive for the rich to work hard. So, income equality would reduce economic growth. It can be inferred from this paper that the result of income inequality on economic growth varies depending on whether the country is developed or not.

As we stated before, there is a large divide in literature as to if income inequality and economic growth are related through a positive or negative relationship. The purpose of this paper is to evaluate the effect of income inequality on economic growth and to contribute relevant findings to the discussion by examining extensive datasets from the World Bank ranging from 1981 to 2014, which enables us to do a long-term comparison case study. The world has been undergoing constant economic change,, and global interconnectedness and interdependence grows and changes each year. To better analyze our data, we incorporate some other important variables that may have an impact (helpful or detrimental) on the relationship between economic growth and inequality.

3. Data

We chose the Gini coefficient (pre-tax) for the explanatory variable (x) in our simple regression line. The Gini coefficient was chosen for this model because it is a common measure of income inequality across many countries that represents the income distribution of a country's residents, where 0 represents perfect equality and 100 represents max inequality, and is recognized and used in much of the literature. Annual growth percentage of gross domestic product (GDP) was the dependent variable (y). The Gini coefficient and GDP growth datasets in this paper were obtained from the World Bank's Development Research Group (World Bank, 2011). We chose to regress GDP growth on the Gini coefficient because most of the literature we referenced found income inequality to have a more marked effect on GDP growth than GDP growth on income inequality. Our ultimate objective was to find the relationship between income inequality and economic growth. However, there are numerous variables that may affect economic growth, including urbanization ratio, population growth rate, financial development (M2/GDP), openness (export/GDP), etc (Li and Zou, 1998). In order to better understand and analyze the effect of income inequality on GDP growth, we controlled for other factors that had the most significant impacts on economic growth in an economy. These variables were gross savings, unemployment rate, education (mean school years), and fertility rate. Gross savings (World Bank, 2011) is one of the most common indicators of the growth of a country because it reflects the country's ability to consume and save. Fertility rate was included because research has shown that lower fertility rates lead to economic growth. Unemployment rate (World Bank, 2011) represents the long term unemployment rate, or natural rate of unemployment, in a country. Unemployment rate is an obvious indicator of a country's economic well-being. The mean school years are also expected to have an impact on economic growth. The more educated a country, the more growth is to be expected because of the capacity for high-skilled laborers. Finally, a dummy variable was used to measure if the level of development of a country would affect their economic growth. These two categories (developed and developing) were classified according to the World Bank classification system.

A summary of the variables is provided in Table 1 below.

Table 1: Variable Descriptions

grgdp	Growth of Gross Domestic Product
Gini	Gini Coefficient (measure of inequality)
gsav	Gross savings
fertil	Fertility rate

unemp	Unemployment rate
educ	Mean school years

3.1 Summary Statistics

Table 2 shows the summary statistics for the data. This study was conducted using 225 countries. Because a country's economy can regress, the fact that the minimum of *grgdp* is a negative number is not a huge concern.

Table 2: Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
grgdp	184	3.909663	3.158448	-7.304	12.615
Gini	105	38.0155	8.6441	24.70333	63.38
gsav	160	21.36649	12.6191	-11.5887	60.00212
fertil	184	2.876358	1.4462	1.205333	7.655
unemp	170	8.658712	5.921921	0.3	31.46667
educ	103	8.9109	2.980666	.055963	13.72269
dev	186	0.1827	0.3875	0	1

3.2 Gauss Markov Assumptions

This section tests whether the data meets the Gauss Markov Assumptions. For the sake of accuracy and effectiveness, the data and models were required to fit the Gauss-Markov assumptions so that it is ensured that the Ordinary Least Squares (OLS) estimates are accurate, linear, and unbiased. This way, we can see if our data is justifies our multiple linear regression models.

MLR 1: The model is linear in parameters. Y = β0 + β1X1 + … + βkXk + u, thus our model meets assumption one.

MLR 2: There is a random sampling of regressors. Countries selected at random without a particular reason yield a random sampling. We collected data from random countries in the world according to the World Bank and obtained our sample from whatever data points were available during the year 2011, our year of study. Thus, our model meets assumption two.

MLR 3: There is no perfect collinearity between any of the regressors Table 3 illustrates that there is no perfect collinearity between any of the regressors, therefore our model meets assumption three.

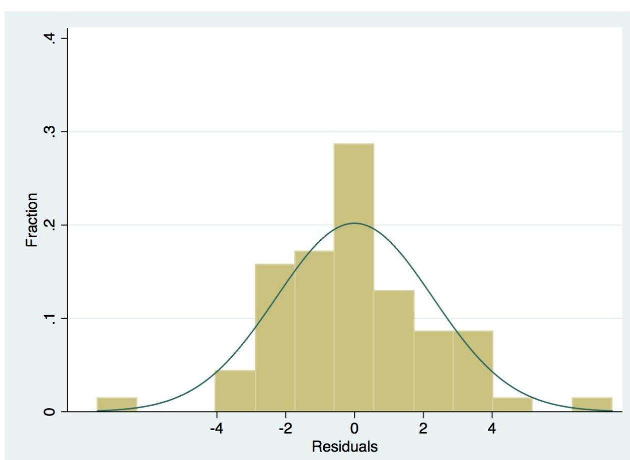
Table 3: Correlation Among Variables

	grgdp	*Gini*	*gsav*	*fertil*	*unemp*	*educ*
grgdp	1.0000					
Gini	0.3943	1.0000				
gsav	0.3769	-0.0118	1.0000			
fertil	0.4549	0.3233	-0.0422	1.0000		
unemp	-0.3815	0.0274	-0.3224	-0.2558	1.0000	
educ	-0.4028	-0.4369	0.1541	-0.6355	0.1802	1.0000

MLR 4: According to the zero conditional mean, the expected value of error given all explanatory values equals 0. Through calculation of the residuals, this was tested and proven. Figure 1 shows the mean of the residuals for the multiple linear regression model tested was about zero.

MLR 5: The error *u* has the same variance given any value of the explanatory variables. The residual distribution must approximate a normal curve. Our model should reflect the best linear unbiased estimators (B. L. U. E. s). Sowe conducted several multiple regression models as well as plot the residuals. The residual distribution in Figure 1 approximates a normal curve, so our model fulfills the fifth assumption.

Figure 1: Residuals PDF



PDF of residuals from regressing *grgdp* on *gini*, *gsav*, *unemp*, *educ*, and *fertil*.

4. Results

4.1 Simple Linear Regression Model

The purpose of the simple linear regression model is to test the relationship between GDP growth and the Gini coefficient. To test this relationship, GDP Growth was only regressed on the Gini coefficient.

$$\textbf{Model 1: } grgdp = \beta_0 + \beta_1 Gini + u$$

The results of this regression are shown in the following table, Table 4 (see also Table A1, Appendix 2).

Table 4: Results of Regression Estimation for Model 1

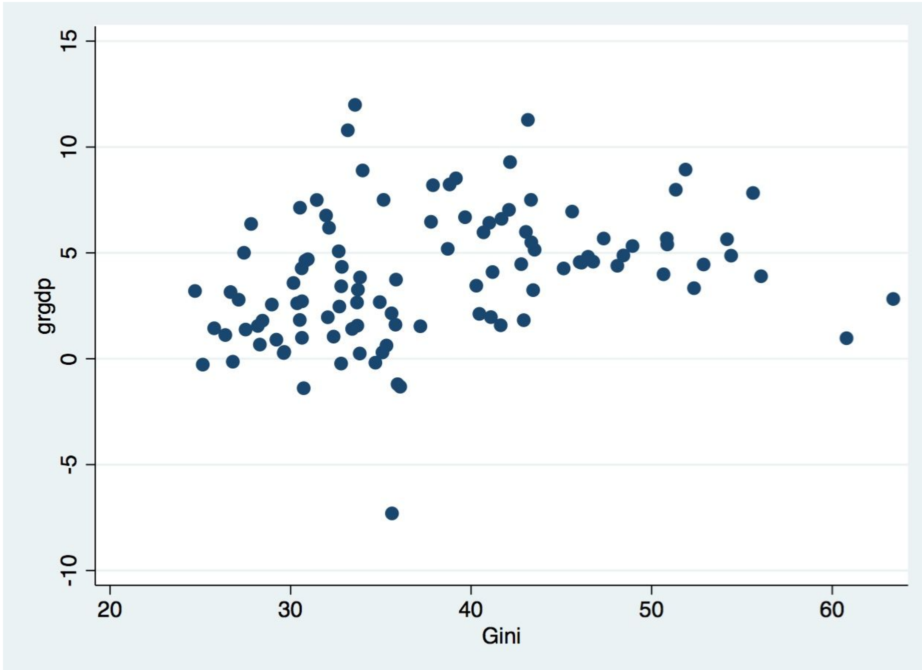
OLS: n=105 Dependent Variable: *grgdp*

Variable	Coefficient	SE	t-value	p-value	Significance
Gini	.1106	.03303	3.35	0.001	***
Constant	-.3067	1.2874	-.24	0.812	

*, **, *** denotes significance of coefficients at 10%, 5%, and 1% respectively.

The results showed a positive relationship between the Gini coefficient and GDP growth, which can be seen in Figure 2 with a scatterplot of GDP grown (5) on the Gini Coefficient. This indicates that for one unit increase in Gini coefficient, the GDP growth rate increases by 11.06 percent. Since the intercept is negative, this means that with zero inequality (Gini equals zero), there would be negative growth. This is a reasonable inference because perfect inequality, which is what is assumed be no inequality, would allow the assumption of negative growth. The p-value of Gini was 0.001, indicating a very high statistical significance. Also, the R^2 found is 0.0981, which means the Gini coefficient only explains 9.8 percent of the GDP growth in the model--a low value. We found this rather unsatisfactory. The reason could be our sample is too diverse or applies for too many different countries since different countries' situation may vary. For instance, one cannot explain the economic growth of some countries with a universal model. Or, this could indicate a non-linear relationship. In our subsequent research, we will build more models using different sets of datas, hoping to find a theory to explain it.

Figure 2: Scatterplot of GDP Growth (%) vs Gini Coefficient



4.2 Multiple Linear Regression Models

We constructed several more multiple regression models to account for other factors or variables with economic significance that may affect economic growth, and to remove any omitted variable bias. These new variables were chosen to control for the Gini coefficient. GDP growth was regressed on the Gini coefficient and 4 new explanatory variables. Table 5 shows the regression estimates for each model and whether they are significant at 10%, 5%, and 1% (*, **, and *** respectively). The additional variables were gross savings, unemployment rate, years of education, and fertility rate. The Gini coefficient was consistently maintaining a positive relationship with GDP growth, as shown in Figure 2. All the variables had positive relationships with GDP growth except for unemployment, which had a negative relationship. While the intercept was consistently negative, this could be due to a strong effect from the Gini coefficient or due to fluctuations in the magnitude of the intercept. The R-squared values did not fluctuate too widely (with the exception of the estimates related to the dummy variable).

Model 2, our first multiple regression model, included the Gini coefficient and the gross savings rate.

$$\textbf{Model 2: } grgdp = \beta_0 + \beta_1 Gini + \beta_2 gsav + u$$

Model 2 in Table 5 shows the regression estimation equation results. In Model 2, both independent variables were positive and significant at the 1% level. The R^2 value was 0.199, which increased from the R^2 value of 0.098 for the simple regression model Model 1.

In the following model, Model 3, the variable *fertil*, for fertility rate, was added to the preexisting variables Gini coefficient and gross savings.

Model 3: $\boldsymbol{grgdp = \beta_0 + \beta_1 Gini + \beta_2 gsav + \beta_3 fertil + u}$

The table yields results that show that fertility rate was also a positive and significant relation to GDP growth. The Gini coefficient and the gross savings rate retained significance in Model 3.The Gini coefficient is now significant at the 5% level, while gross savings and fertility rate were significant at the 1% level. The R^2 value increased to 0.385, which means that the variables explain 38.5% of the variation in *grgdp*. This makes sense because as we control for more variables, the larger R^2 will be.

In Model 4 we added the unemployment rate, which although proved to be significant alongside the other variables, had a negative relationship with GDP growth. The Gini coefficient maintained significance at the 5% level, like the unemployment rate, while gross savings and fertility rate remained significant at the 1% level. The R^2 value for this model increased once more to 0.423.

Model 4: $\boldsymbol{grgdp = \beta_0 + \beta_1 Gini + \beta_2 gsav + \beta_3 fertil + \beta_4 unemp + u}$

In Model 5 we incorporated the variable educ, which represents mean years of education. The mean years of education had a negative relationship with GDP growth. This new variable differed from all the other variables because it was not statistically significant at the 10%, 5%, or 1% levels. The Gini coefficient maintained significance at the 5% and 10% levels, while *gsav*, *fertil*, and *unemp* all retained their statistical significance at the 1% level. In addition, the intercept was not statistically significant at any level in this model, unlike the other models. Therefore, we can conclude from these results that the Gini coefficient, gross savings, fertility rate, and unemployment all have an impact on GDP growth, while no conclusions can be made about education. The R^2 value rose once more to 0.478, which means that 47.8% of the variation can be explained by the model. Model 5 is the model we chose as our restricted model after testing for correlation of variables. A value of positive or negative one would be a perfect correlation while a value of zero is no correlation. These results are shown in Appendix 2 Table A7.

Model 5: $grgdp = \beta_0 + \beta_1 Gini + \beta_2 gsav + \beta_3 fertil + \beta_4 unemp + \beta_5 educ + u$

After we had constructed and analyzed these models, we decided to add a dummy variable to show the difference between developed and developing countries. This dummy variable, "dev", is shown in Model 6's regression. According to Model 6, compared to the intercept of the developing countries of -0.645, the developed countries had an intercept of -3.995. This model also had the highest R^2 value of 0.632 and the smallest number of observations. This is much larger than the previous values, but expected, as increasing the number of variables always increases the R2 value. These differences in information gathering may be the cause of some of the differences in models. The correlation among variables with the inclusion of the dummy variable can be found in the Appendix 2, Table A8.

Model 6: $grgdp = \beta_0 + \beta_1 Gini + \beta_2 gsav + \beta_3 fertil + \beta_4 unemp + \beta_5 educ + \beta_6 dev + u$

Table 5: OLS Regression Estimates for Models 1-6

Dependent Variable *grgdp*						
Independent Variables	SLR Model 1	MLR Model 2	MLR Model 3	MLR Model 4	MLR Model 5	MLR Model 6
Gini	0.111*** (0.033)	0.114*** (0.317)	0.067** (0.029)	0.073** (0.029)	0.0885** (0.035)	0.046 (0.031)
gsav		0.103*** (0.029)	0.134*** (0.026)	0.115*** (0.027)	0.118*** (0.033)	0.115*** (0.028)
fertil			1.033*** (0.193)	0.893*** (0.205)	0.656* (0.330)	0.655** (0.28)
unemp				-0.098** (0.047)	-0.093* (0.051)	-0.111** (0.436)
educ					-0.165 (0.129)	0.075 (0.119)
dev						-3.349*** (0.654)
Intercept	-0.307 (1.287)	-2.644* (1.402)	-4.107*** (1.265)	-2.751* (1.413)	-1.376 (2.422)	-0.645 (2.056)
No. of obs	105	99	99	97	70	70
R-square	0.098	0.199	0.385	0.423	0.478	0.632

The quantities in parentheses are standard errors. *, **, *** denotes significance of coefficients at 10%, 5%, and 1% respectively.

The results yielded from the regressions support our hypothesis that GDP growth and the Gini coefficient are positively related. Depending on the model used, a one point increase in the Gini coefficient can result in about an 11% increase in GDP growth. This may be caused by an unequal distribution of wealth in an economy with income inequality. Essentially, as inequality increases, the majority of the wealth of the economy is concentrated in the hands of the top percentage of the people. This can then increase GDP growth through investment. Unsurprisingly, gross savings and the GDP growth in an economy are positively associated. With a 1% increase in gross savings, there is (depending on the model) a 10-13% increase in GDP growth. These findings support Shin's (2012) and Malinen's (2013) research that an increase in the level of saving in an economy will enhance growth. These results also support Aghion, Comin, Howitt and Tecu (2009) which states that increased savings may increase innovation and therefore foreign investment in technology, which in turn would have a positive effect on the economy. Fertility also has a positive impact on the economy. As the population of a country grows, more people are added to the labor force and the country is more productive. In fact, a fertile population of a country signifies health and potential for growth as well. According to our findings, fertility rate is actually one of the more influential variables of an economy's GDP growth. Unemployment, unsurprisingly, has a negative correlation with GDP growth. An increase in unemployment results in a decrease in a country's GDP growth, and vice versa. As unemployment rate increases in a country's economy, there are social and economic implications and repercussions. Generally, unemployment is negatively related to disposable income as well. This results in reduced consumption which will lead to reduced economic growth. Finally, the statistics show that mean years of education does not have statistical significance in these models. Interestingly, the correlation between mean years of education changes from negative to positive when the dummy variable is added. This model including the dummy variable is something that should be further investigated.

4.3 Statistical Inferences

Looking at the regression models created, we can see which factors have a positive impact on economic growth and which factors have a negative impact on economic growth. Our models unanimously demonstrated that the Gini coefficient, the gross savings rate, and fertility rate had a positive effect on GDP growth, while unemployment and education had a negative correlation with economic growth (not encompassing the model including the dummy variable). Also, for each regression, two-tailed t-tests were performed on each variable. The null stated that the coefficient of the variable equaled zero, and the alternative hypothesis stated that it did not equal zero. The tests were then examined at the 1%, 5%, and 10% significance level. The t-values and p-values that resulted are in the appendix. In conjunction with the simple regression model, we found that the Gini coefficient was statistically significant at all three levels, and decreased in significance slightly (5% and 1%) when independent variables were added for the construction of Models 2-6. The variables with a positive effect on GDP growth (gross savings and fertility rate) consistently were statistically significant at all three levels, while unemployment, the negatively correlated variable, was consistently significant at the 5% and 10% levels. The significance of the intercept varied widely throughout the tests, and so we cannot conclude much about its statistical significance with our current research results. However, we can conclude that from this model, all variables had an impact on GDP growth.

Looking at the growth rate of developing countries compared to developed countries, on average, developing countries had higher GDP growth rate than developed countries. This could be explained by inequality in those countries. Unequal distribution can result in more economic mobility, especially in developing countries or countries in the early stages of development (Aghion, Caroli, Garcia-Penalosa 1999). While this may be a possible explanation, it is not something that we have adequate research or results to back a claim at this point, as it was not our focus for this research. However, our hypothesis was supported by the simple and multiple regression models performed on the data collected. Unsurprisingly, gross savings, and fertility had a positive relationship with economic equality, and unemployment and education had a negative relationship. On average the developing countries had a higher economic growth regardless of the initial GDP per capita as shown by our data.

4.4 Robustness

All of our explanatory variables proved to be statistically significant when using the t-test. However, just in case that we had missed any other possible relations among our variables, we conducted the f-test in order to check whether our control variables had an impact on GDP growth. The null hypothesis and alternative hypothesis did not change: the null stated that the coefficients on the control variables equaled zero and the alternative hypothesis stated that at least one was not equal to zero. For our f-test, the restricted model was Model 5, which put out a sum of squared residuals (SSR_R) of 356.810. Our unrestricted model was Model 6, the model including the dummy variable, which yielded a sum of squared residuals (SSR) of 251.894. With these findings, we calculated the f-statistic for both the restricted and unrestricted models using the equation $F = [(SSR_R - SSR_{UR})/q]/[SSR_{UR}/(n-k-1)]$, where q represents the number of restrictions imposed on the restricted model (4 for our model). The degrees of freedom are represented by (n-k-1) in the unrestricted model, which is 63 for this model. This equation yields an f-statistic of 18.01. This is a fairly large f-statistic, so we can conclude that our variables may be jointly significant at a very low α level. In other words, the model is useful in predicting GDP growth. Thus, although education is not individually significant, it has a joint effect on GDP growth in conjunction with the other control variables.

5. Conclusion

In general, considering all the variables, the OLS regression models show a positive relationship between income inequality and economic growth. For our restricted model, we found that a one point increase in the Gini coefficient leads to an increase in GDP growth by 8.85%, and for the unrestricted model, a one point increase in the Gini coefficient leads to an increase in GDP growth by 4.56%. Another interesting result was that the Gini coefficient and gross savings rate were statistically significant at the !% level, while fertility rate and unemployment were statistically significant at at least the 10% level. Education, however, was not statistically significant in this study, and therefore we needed to conduct an f-test to determine if mean years of education had a joint impact on economic growth with the other control variables. The results of the f-test revealed to us that education still had an impact on GDP growth in conjunction with the other variables despite being individually insignificant.

We decided for our purposes, Model 5 was the best representation of our result for this study. Further research needs to be conducted to investigate the negative relationship between mean years of education and economic growth. In addition, more variables should be added and studied to see if there are other forces that influence economic growth in a country. Finally, further study into how country development can or may impact the GDP growth should be investigated.

In conclusion, we recognize that income inequality is a topic that is frequently discussed right now, especially with the Presidential election of 2016. Arguments for increase of minimum wage to reduce income inequality is a topic brought up frequently. Even according to existing literature, there are examples of how income inequality can improve the conditions of the inhabitants of a country as well as data that shows income inequality is related to many economic and social dilemmas that a country may face. Therefore, a country should seek to attain a good balance between income inequality and the repercussions so as to achieve the most optimal economic growth.

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Appendices

Appendix 1: List of Countries

Andorra	Bosnia and Herzegovina	Comoros	Fiji	Indonesia	Lao PDR	Montenegro	Peru	Serbia	Tuvalu
Afghanistan	Belrus	Cabo Verde	France	India	Lebanon	Mongolia	Philippines	South Sudan	Tanzania
Angola	Belize	Costa Rica	Gabon	Ireland	Liberia	Mozambique	Papua New Guinea	Sao Tome and Principe	Uganda
Albania	Bermuda	Cuba	United Kingdom	Iran, Islamic Rep	St. Lucia	Mauritania	Poland	Suriname	Ukraine
United Arab Emirates	Bolivia	Cyprus	Georgia	Iraq	Sri Lanka	Mauritius	Puerto Rico	Slovak Republic	Uruguay
Argentina	Brazil	Czech Republic	Ghana	Iceland	Lesotho	Malawi	Portugal	Slovania	United States
Armenia	Barbados	Germany	Guinea	Israel	Lithuania	Malaysia	Paraguay	Sweden	Uzbekistan
Antigua and Barbuda	Bhutan	Djibouti	Gambia	Italy	Luxembourg	Namibia	Qatar	Swaziland	Venuzuela, RB
Australia	Botswana	Dominica	Guinea-Bissau	Jamaica	Latvia	Niger	Romania	Seychelles	Vietnam
Austria	Central African Republic	Denmark	Greece	Jordan	Macao	Nigeria	Russian Federation	Chad	Vanuatu
Azerbaijan	Canada	Dominican Republic	Grenada	Japan	Morocco	Nicaragua	Rwanda	Togo	Samoa
Burundi	Switzerland	Algeria	Guatemala	Kazakhstan	Moldova	Netherlands	Saudi Arabia	Thailand	Yemen, Rep
Belgium	Chile	Ecuador	Guyana	Kenya	Madagascar	Norway	Sudan	Tajikistan	South Africa
Benin	China	Egypt, Arab Rep	Hong Kong	Kyrgyz Republic	Mexico	Nepal	Senegal	Timor-Leste	Congo, Dem Rep
Burkina Faso	Cote d'Ivoire	Spain	Honduras	Cambodia	Marshall Islands	New Zealand	Singapore	Tonga	Zambia
Bangladesh	Cameroon	Estonia	Croatia	Korea, Rep	Macedonia, FYR	Oman	Solomon Islands	Trinidad and Tobago	Zimbabwe
Bulgaria	Congo, Rep	Ethiopia	Haiti	Kosovo	Mali	Pakistan	Sierra Leone	Tunisia	
Bahrain	Colombia	Finland	Hungary	Kuwait	Malta	Panama	El Salvador	Turkey	

Appendix 2: STATA Regression Outputs

Table A1: Model 1 regression

```
. regress grgdp Gini
```

Source	SS	df	MS			
				Number of obs	=	105
				F(1, 103)	=	11.20
Model	94.9838139	1	94.9838139	Prob > F	=	0.0011
Residual	873.2102	103	8.47776893	R-squared	=	0.0981
				Adj R-squared	=	0.0893
Total	968.194013	104	9.30955782	Root MSE	=	2.9117

grgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Gini	.1105578	.0330297	3.35	0.001	.045051	.1760645
_cons	-.3067456	1.287393	-0.24	0.812	-2.859985	2.246494

Table A2: Model 2 regression

```
. regress grgdp Gini gsav
```

Source	SS	df	MS			
				Number of obs	=	99
				F(2, 96)	=	11.90
Model	177.357772	2	88.6788861	Prob > F	=	0.0000
Residual	715.456291	96	7.4526697	R-squared	=	0.1987
				Adj R-squared	=	0.1820
Total	892.814063	98	9.11034758	Root MSE	=	2.73

grgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Gini	.114785	.0316657	3.62	0.000	.051929	.177641
gsav	.1027894	.0290295	3.54	0.001	.0451664	.1604124
_cons	-2.644401	1.401742	-1.89	0.062	-5.426837	.1380362

Table A3: Model 3 regression

```
. regress grgdp Gini gsav fertil

      Source |       SS           df       MS      Number of obs   =        99
-------------+----------------------------------   F(3, 95)        =     19.78
       Model |  343.254861         3  114.418287   Prob > F        =    0.0000
    Residual |  549.559202        95  5.78483371   R-squared       =    0.3845
-------------+----------------------------------   Adj R-squared   =    0.3650
       Total |  892.814063        98  9.11034758   Root MSE        =    2.4052

------------------------------------------------------------------------------
       grgdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Gini |   .0670464    .029288     2.29   0.024     .0089024    .1251905
        gsav |   .1337281   .0262202     5.10   0.000     .0816745    .1857817
      fertil |   1.032928   .1928839     5.36   0.000     .6500048    1.415851
       _cons |  -4.107141    1.26482    -3.25   0.002    -6.618125   -1.596157
------------------------------------------------------------------------------
```

Table A4: Model 4 regression

```
 regress grgdp Gini gsav fertil unemp

      Source |       SS           df       MS      Number of obs   =        97
-------------+----------------------------------   F(4, 92)        =     16.78
       Model |  374.417208         4   93.604302   Prob > F        =    0.0000
    Residual |  513.262914        92  5.57894472   R-squared       =    0.4218
-------------+----------------------------------   Adj R-squared   =    0.3967
       Total |  887.680122        96  9.24666794   Root MSE        =     2.362

------------------------------------------------------------------------------
       grgdp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Gini |   .0729762   .0290482     2.51   0.014      .015284    .1306683
        gsav |   .1153335   .0274353     4.20   0.000     .0608446    .1698225
      fertil |   .8932998   .2050265     4.36   0.000     .4860993      1.3005
       unemp |  -.0980788   .0468862    -2.09   0.039    -.1911989   -.0049588
       _cons |  -2.750765   1.413114    -1.95   0.055    -5.557332    .0558023
------------------------------------------------------------------------------
```

Table A5: Model 5 regression

```
. regress grgdp Gini gsav fertil unemp educ
```

Source	SS	df	MS
Model	327.064212	5	65.4128424
Residual	356.810287	64	5.57516074
Total	683.874499	69	9.91122463

Number of obs	= 70
F(5, 64)	= 11.73
Prob > F	= 0.0000
R-squared	= 0.4783
Adj R-squared	= 0.4375
Root MSE	= 2.3612

grgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Gini	.0885431	.0353214	2.51	0.015	.0179804	.1591058
gsav	.1182324	.032796	3.61	0.001	.0527148	.1837499
fertil	.6557092	.330266	1.99	0.051	-.004073	1.315491
unemp	-.0932868	.0513511	-1.82	0.074	-.1958725	.0092988
educ	-.1652503	.1292013	-1.28	0.206	-.4233595	.0928589
_cons	-1.375652	2.421891	-0.57	0.572	-6.213934	3.462631

Table A6: Model 6 (with dummy variable) regression

```
. regress grgdp Gini gsav fertil unemp educ dev
```

Source	SS	df	MS
Model	431.980412	6	71.9967353
Residual	251.894087	63	3.99831885
Total	683.874499	69	9.91122463

Number of obs	= 70
F(6, 63)	= 18.01
Prob > F	= 0.0000
R-squared	= 0.6317
Adj R-squared	= 0.5966
Root MSE	= 1.9996

grgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Gini	.0455729	.0310662	1.47	0.147	-.0165079	.1076537
gsav	.1152639	.0277796	4.15	0.000	.0597509	.1707769
fertil	.6549961	.2796881	2.34	0.022	.0960841	1.213908
unemp	-.1111942	.0436273	-2.55	0.013	-.1983765	-.0240119
educ	.0749356	.1190385	0.63	0.531	-.1629438	.312815
dev	-3.34899	.6537794	-5.12	0.000	-4.655463	-2.042516
_cons	-.6450771	2.055947	-0.31	0.755	-4.75356	3.463406

Table A7: Correlation Table Stata Output

```
. correlate grgdp Gini gsav fertil unemp educ
(obs=70)
```

	grgdp	Gini	gsav	fertil	unemp	educ
grgdp	1.0000					
Gini	0.3943	1.0000				
gsav	0.3769	-0.0118	1.0000			
fertil	0.4549	0.3233	-0.0422	1.0000		
unemp	-0.3815	0.0274	-0.3224	-0.2558	1.0000	
educ	-0.4028	-0.4369	0.1541	-0.6355	0.1802	1.0000

Table A8: Correlation Table Stata Output (with dummy variable)

```
. correlate grgdp Gini gsav fertil unemp educ dev
(obs=70)
```

	grgdp	Gini	gsav	fertil	unemp	educ	dev
grgdp	1.0000						
Gini	0.3943	1.0000					
gsav	0.3769	-0.0118	1.0000				
fertil	0.4549	0.3233	-0.0422	1.0000			
unemp	-0.3815	0.0274	-0.3224	-0.2558	1.0000		
educ	-0.4028	-0.4369	0.1541	-0.6355	0.1802	1.0000	
dev	-0.5772	-0.4582	0.0807	-0.3627	0.0132	0.5664	1.0000

Summary Tables of Variables:

```
. summarize Gini

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
        Gini |        105    38.01552    8.644083   24.70333      63.38

. summarize grgdp

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       grgdp |        184    3.909663    3.158448  -7.304008   12.61569

. summarize gsav

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
        gsav |        160    21.36649     12.6191   -11.5887   60.00212

. summarize fertil

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      fertil |        184    2.876358      1.4462   1.205333      7.655

. summarize unemp

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       unemp |        170    8.658712    5.921921         .3   31.46667

. summarize educ

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
        educ |        103    8.910904    2.980666     .55963   13.72269

. summarize dev

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
         dev |        186    .1827957    .3875421          0          1
```